

GOLF BALL OF UNITARY MOLDED CONSTRUCTION

CROSS-REFERENCE TO RELATED APPLICATION

This application is a continuation-in-part application of U.S. Patent Application No. 10/347,720 filed on January 21, 2003, which application is incorporated
5 herein by reference in its entirety.

TECHNICAL FIELD

The present invention relates generally to golf balls, and more specifically, to one piece golf balls of unitary molded construction that are suitable for shorter and "off-course" playing, as well as to methods of manufacturing relating thereto.

10 BACKGROUND OF THE INVENTION

Golf balls have traditionally been categorized into three different groups; namely, (1) one piece golf balls of unitary molded construction, (2) multi-piece golf balls (*i.e.*, two or more concentric pieces) of layered construction, and (3) wound golf balls (*i.e.*, core consists of a wound elastic thread) of layered construction. The physical and
15 structural differences among these three distinct groups of golf ball construction are very significant; as are the differences in their play characteristics.

The wound golf ball (frequently referred to as a three piece golf ball), for example, is generally made from a vulcanized rubber thread wound under tension around a solid or semi-solid center to form a wound core. The wound core is then encased in a
20 single or multi-layer covering of one or more tough protective materials. Similarly, the multi-piece golf ball is generally made from a solid resilient core having single or multiple cover layers thereon. In both types of layered golf ball, the materials of the inner layers tend to vary significantly, while the material of the outermost cover layer is most commonly either balata or SURLYN (E.I. duPont de Nemours and Company, United
25 States). In this regard, it is generally believed that SURLYN provides a stronger, more durable cover, whereas balata provides a softer cover that offers a bit more spin control.

Regardless of the cover layer material, golf balls of layered construction have evolved significantly over the years to achieve, among other things, better flight and distance characteristics (innovations made possible, in part, by the development of new synthetic polymers and other specialty chemicals). Indeed, searchable databases maintained by the
5 U.S. Patent and Trademark Office reveal that several thousand U.S. patents have thus far been issued on inventions relating to golf balls of layered construction.

In contradistinction, one piece golf balls of unitary molded construction are typically formed from a homogeneous mass of a moldable synthetic material. As such, golf balls of this type of construction generally possess a homogeneous composition
10 (*i.e.*, the composition is substantially uniform between the interior and exterior of each ball); and there is generally no separate outer protective covering. One piece golf balls of unitary molded construction are known in the art and have been described over the years in the patent literature. Exemplary in this regard are U.S. Pat. No. 3,238,156, U.S. Pat. No. 3,239,228, U.S. Pat. No. 3,241,834, U.S. Pat. No. 3,313,545; U.S. Pat. No. 3,373,123, U.S.
15 Pat. No. 3,384,612, U.S. Pat. No. 3,421,766, U.S. Pat. No. 3,438,933, U.S. Pat. No. 3,452,986, U.S. Pat. No. 3,992,014, U.S. Pat. No. 4,165,877, U.S. Pat. No. 4,266,772, U.S. Pat. No. 4,836,552, U.S. Pat. No. 4,839,116, U.S. Pat. No. U.S. 5,082,285, U.S. Pat. No. 5,330,837, and U.S. Pat. No. 6,277,924. In general, the unitary golf balls described in these patents are suitable only for practice, and not competitive play. More importantly,
20 however, is that these patents reveal that relatively few technological innovations have been made over the years with respect to one piece golf balls, especially with respect to the use of newly developed synthetic polymers and other specialty chemicals.

Specifically, and although numerous attempts have been made to manufacture one piece golf balls of unitary molded construction, a one piece golf ball has
25 not yet been developed that is both relatively lightweight and able to “pop” off a club face like that of a layered construction golf ball. In addition, there has not yet been developed a one piece golf ball that has great elasticity and bouncing characteristics and that is suitable for shorter or off-course playing. Accordingly, there is still a need in the art for novel golf balls of unitary molded construction, as well as to methods of manufacturing relating

thereto. The present invention fulfills these needs and provides for further related advantages.

SUMMARY OF THE INVENTION

In brief, the present invention relates generally to golf balls, and more specifically, to one piece golf balls of unitary molded construction suitable for shorter (*e.g.*, par 3 courses) and “off-course” playing, as well as to methods of manufacturing relating thereto. In one embodiment, the present invention is directed to a golf ball of unitary molded construction, wherein the entire golf ball is foamed from a composition that comprises an ethylene-vinyl acetate copolymer, a thermoplastic elastomer, and a blowing agent. The golf ball in this embodiment may have (i) a diameter that ranges from about 1.6 to about 2.4 inches, (ii) a weight that ranges from about 10 to about 28 grams, and/or (iii) a coefficient of restitution value that ranges from about 0.30 to about 0.45, and more preferably ranges from about 0.33 to about 0.42. The ethylene-vinyl acetate copolymer component generally ranges from about 0 to about 99 weight percent of the total composition, and preferably ranges from about 40 to about 90 percent of the total composition, and more preferably ranges from about 60 to about 70 percent of the total composition. Similarly, the thermoplastic elastomer component also generally ranges from about 0 to about 99 weight percent of the total composition, and preferably ranges from about 5 to about 60 percent of the total composition, and more preferably ranges from about 10 to about 25 percent of the total composition. In addition, the blowing agent component generally ranges from about 1 to about 13 weight percent of the total composition, and preferably ranges from about 5 to about 9 percent of the total composition. The composition used to make to golf balls of the present invention may further comprise one or more processing additives and/or colorants as is appreciated by those skilled in the art. For example, a small amount of polypropylene may be added to the composition as it tends to reduce certain surface imperfections such as undesirable branched or swirled “brain-like” surface indicia. The amount of polypropylene that may be added ranges from about 0 to about 10 weight percent of the total composition, and

preferably ranges from about 1.5 to about 6.5 weight percent of the total composition, and more preferably from about 5 to about 6 weight percent of the total composition.

In another embodiment, the present invention is directed to a golf ball of unitary molded construction, wherein the golf ball is foamed from a composition comprising: (i) a major amount by weight of an ethylene-vinyl acetate copolymer; (ii) a minor amount by weight of a thermoplastic elastomer material; and (iii) a blowing agent. The thermoplastic elastomer material associated with several embodiments disclosed herein may be one or more of (i) a thermoplastic elastomer based on a dynamically vulcanized elastomer-thermoplastic blend, (ii) a styrene tri-block copolymer thermoplastic elastomer, and (iii) an ethylene- α -olefin copolymer thermoplastic elastomer.

In yet another embodiment, the present invention is directed to a method of making a golf ball of unitary molded construction. In this embodiment, the method comprises at least the following steps: compounding a polymeric composition from the ingredients comprising an ethylene-vinyl acetate copolymer and a thermoplastic elastomer; combining the polymeric composition with a blowing agent to yield a feedstock; injecting the feedstock into a mold having a substantially spherical shape; and cooling the mold to form the golf ball. The method may further comprise the step of quenching the golf ball in an agitated water bath. The present invention is also directed to a golf ball made in accordance with these methods.

These and other aspects of the present invention disclosed herein will become more evident upon reference to following detailed description.

DETAILED DESCRIPTION OF THE INVENTION

As noted above, the present invention relates generally to golf balls, and more specifically, to one piece golf balls of unitary molded construction suitable for shorter and "off-course" playing, as well as to methods of manufacturing relating thereto. In some embodiments, the golf balls of the present invention comprise a thermoplastic elastomer material admixed together with an ethylene-vinyl acetate copolymer. More specifically, it has been discovered that unitary golf balls made from a composition comprising (i) one or

more thermoplastic elastomer materials, (ii) an ethylene-vinyl acetate copolymer, and (iii) other optional fillers and/or processing additives, have highly desirable properties and characteristics which make them highly desirable for shorter and "off-course" playing. For example, it has been surprisingly discovered that, among other things, golf balls made from such novel compositions are highly suitable for "off-course" playing because they are highly elastic (and thus have a good "spring" feel when hit off a club face), durable, and travel only about one-third to about one-half as far as a conventional golf ball of layered construction. In addition, the unitary golf balls of the present invention are, in general, relatively less expensive to produce than many other types of practice or off-course golf balls.

In some exemplary embodiments, the unitary golf balls of the present invention are made of a foamed thermoplastic elastomer / ethylene-vinyl acetate copolymer admixture that has been molded into the shape of a standard sized golf ball (*i.e.*, golf ball having a diameter of about 1.68 inches). However, it is to be understood that unitary golf balls of nonstandard sizes (*e.g.*, golf ball with diameters ranging from about 1.6 inches or less to about 2.4 inches or more) may likewise be made. The thermoplastic elastomer component of such an admixture is preferably a styrene tri-block copolymer thermoplastic elastomer, and the ethylene-vinyl acetate copolymer preferably has a vinyl acetate content ranging from about 15% to about 18%. The weight of each such exemplary golf ball generally ranges from about 10 to about 28 grams (and preferably from about 12 to about 16 grams); whereas the "coefficient of restitution" (COR) generally ranges from about 0.33 to about 0.42 (and preferably from about 0.36 to about 0.39). As is appreciated by those skilled in the art, the "coefficient of restitution" is simply a measure of the ratio of the relative velocity of an elastic sphere immediately before and after a direct impact. The "coefficient of restitution" can vary from zero to one, with one being equivalent to a completely elastic collision and zero being equivalent to a completely inelastic collision.

Because many embodiments of the present invention encompass a wide range of possible polymer compositions – particularly with respect to ingredients such as, for example, thermoplastic elastomer materials and ethylene-vinyl acetate copolymers –

relevant disclosure has been included pertaining to the following: (1) overview of polymer nomenclature and theory (2) suitable thermoplastic elastomer materials; (3) suitable ethylene-vinyl acetate copolymers; (4) suitable additives; (5) exemplary compounding techniques; and (6) exemplary unitary golf ball manufacturing processes. In addition, several illustrative Examples have also been included that help demonstrate some of the novel features and characteristics associated with the unitary golf balls of the present invention. Finally, and although many specific details of certain embodiments of the present invention are set forth below, it is to be understood that the present invention may have additional embodiments, and that the invention may be practiced without several of the details described herein.

For purposes of clarity, a brief review of polymer nomenclature is provided to aid in the understanding of the present invention. In general, a polymer is a macromolecule (*i.e.*, a long chain molecular chain) synthetically derived from the polymerization of monomer units or which exists naturally as a macromolecule (but which is still derived from the polymerization of monomer units). The links of the molecular chain are the monomer units. For example, polypropylene is a polymer derived from the monomer propylene (CH_2CHCH_3). More specifically, polypropylene is a “homopolymer,” that is, a polymer consisting of a single repeating unit, namely, the monomer propylene (CH_2CHCH_3).

In contrast, a “copolymer” is a polymer containing two (or more) different monomer units. A copolymer may generally be synthesized in several ways. For example, a copolymer may be prepared by the copolymerization of two (or more) different monomers. Such a process yields a copolymer where the two (or more) different monomers are randomly distributed throughout the polymer chain. These copolymers are known as “random copolymers.” Alternatively, copolymers may be prepared by the covalent coupling or joining of two homopolymers. For example, the covalent coupling of one homopolymer to the terminus of a second, different homopolymer provides a “block copolymer.” A block copolymer containing homopolymer A and homopolymer B may be schematically represented by the following formula: $(\text{A})_x(\text{B})_y$ where $(\text{A})_x$ is a

homopolymer consisting of x monomers of A, $(B)_y$ is homopolymer consisting of y monomers of B, and wherein the two homopolymers are joined by a suitable covalent bond or linking spacer group. While the above formula illustrates a block copolymer having two block components (*i.e.*, a “di-block copolymer”), block copolymers may also have three or more block components (*e.g.*, a “tri-block copolymer” schematically represented by the formula $(A)_x(B)_y(A)_x$ or simply A-B-A, as well as a “multiblock copolymer” schematically represented by the formula $(-A-B)_n$).

As noted above, exemplary thermoplastic elastomer materials (*i.e.*, TPEs) of the present invention include, but are not limited to, any one or combination of the following: thermoplastic polyurethane elastomers (*i.e.*, TPUs), polyolefin-based thermoplastic elastomers (*i.e.*, TPOs), thermoplastic elastomers based on dynamically vulcanized elastomer-thermoplastic blends (*i.e.* TPVs), thermoplastic polyether ester elastomers, thermoplastic elastomers based on halogen-containing polyolefins, thermoplastic elastomers based on polyamides, styrene based thermoplastic elastomers, and ethylene- α -olefin copolymer thermoplastic elastomers. As is appreciated by those skilled in the art, many of these materials may be characterized (unlike conventional single-phase thermoplastic materials) as having one or more copolymers that comprise a major proportion of a soft segment and a minor proportion of a hard segment so as to result in a composition having a two-phase morphology.

Without necessarily prescribing to any specific scientific theory, it is believed that many of the thermoplastic elastomers utilized in the present invention possess unique thermal and mechanical properties because they consist of hard segments that have a high glass transition temperature (T_g) or melting temperature (T_m) alternating with soft segments that have a low T_g (\ll room temperature). In addition to these constraints, the hard and soft segments are generally chosen such that the free energy of mixing is positive. As such, the mutual incompatibility of the segments induces microphase separation in the solid state: the hard segments tend to aggregate to form glassy or semicrystalline hard domains interspersed in a continuous soft segment matrix (hence, a two-phase morphology). The boundaries between these two phases are not well defined because there

exists some degree of forced compatibility due to the relatively short average chain lengths and molecular weight distributions (*i.e.*, generally below 4,000 atomic mass units) associated with each of the two types of segments.

5 In addition to the foregoing and as further appreciated by those skilled in the art, the soft segments contribute to the flexibility and extensibility of the thermoplastic elastomer, whereas the glassy or semicrystalline domains of the hard segments serve as physical crosslinks that impedes chain slippage and viscous flow. Because the crosslinks associated with the hard segments are physical in nature (in contradistinction to the chemical bonds found in vulcanized rubber), they are thermally reversible. As such, 10 heating above the softening or melting point of the hard segment generally causes the hard domains to disassociate and become fluid. Without the hard segment tie points, the thermoplastic elastomer is able to flow, and therefore can be melt processed in conventional thermoplastic processing equipment, such as, for example, conventional injection molding equipment.

15 Moreover, it is to be understood that the polymer chains associated with the soft and hard segments may be synthesized with any number of monomer units – so as to range from short to long – wherein the soft and hard segment chain lengths define, in large part, the physical properties of the thermoplastic elastomer. The lengths of the soft and hard segments notwithstanding, any of the thermoplastic elastomer materials (as well as 20 various combinations thereof) disclosed herein may be used to produce the golf balls of the present invention. For purposes of added clarification, the several different classifications of the above-identified thermoplastic elastomer materials are more fully identified and described below.

25 The thermoplastic polyurethane elastomers (*i.e.* TPUs) of the present invention are generally made from long-chain polyols with an average molecular weight of 60 to 4,000, chain extenders with a molecular weight of 61 to 400, and polyisocyanates. Within the genus of TPUs, the soft flexible segments generally comprise either hydroxyl terminated polyesters or hydroxyl terminated polyethers, whereas the hard segments generally comprise 4,1'-diphenylmethane diisocyanate. The hard segments may, however,

comprise hexamethylene diisocyanate, 4,4''-dicyclohexylmethane diisocyanate, 3,3'-dimethyl-4,4''-biphenyl diisocyanate, 1,4-benzene diisocyanate, *trans*-cyclohexane-1,4-diisocyanate, and 1,5-naphthalene diisocyanate. As is appreciated by those skilled in the art, the characteristics of the hard segment and to a large extent the physical properties of the TPU are generally determined by the choice of the polyisocyanate and its associated chain extender. In the context of the present invention, the most important chain extenders for the above-identified TPUs are linear diols such as, for example, ethylene glycol, 1,4-butanediol, 1,6-hexanediol, and hydroquinone bis(2-hydroxyethyl) ether. Exemplary of the commercially available TPU thermoplastic elastomers include those available from DuPont (I.E. Du Pont de Nemours and Company, United States) under the tradename HYLENE, as well as those available from Morton (Morton International Specialty Chemicals) under the tradename IROGRAN.

The polyolefin-based thermoplastic elastomers (*i.e.* TPOs) of the present invention generally include random block copolymers (*e.g.*, ethylene α -olefin copolymers), block copolymers (*e.g.*, hydrogenated butadiene-isoprene-butadiene block copolymers), stereoblock polymers (*e.g.*, stereoblock polypropylene), graft copolymers (*e.g.*, polyisobutylene-g-polystyrene and EPDM-g-pivalolactone), and blends (*e.g.* blends of ethylene-propylene random copolymer with isotactic polypropylene and dynamically vulcanized blends of EPDM with a crystalline polyolefin). As is appreciated by those skilled in the art, all of these thermoplastic elastomers generally depend on crystallization of polymer chains to produce an elastomeric structure. For example, in the TPO random block copolymers (which are structurally similar to TPU random block copolymers) ethylene sequences long enough to crystallize at use temperature act as physical crosslinks for the amorphous elastic chain segments. In the TPO stereoblock copolymers, changes in intrachain tacticity (*i.e.*, alternating stereoregularities) provide for the alternating crystalline and amorphous sequences. Furthermore, those skilled in the art recognize that many TPO thermoplastic elastomers embrace more than one thermoplastic elastomer classification as set forth above.

The thermoplastic elastomers based on halogen-containing polyolefins of the present invention include those thermoplastic elastomers having halogen atoms attached to the polymer backbone, as well as some blends of poly(vinyl chloride) (PVC) with crosslinked or elastomeric polymers. Exemplary in this regard is melt-processable
5 rubber (MBR), as well as blends of PVC with acrylonitrile-butadiene elastomer (NBR), copolyester (CPO), and some thermoplastic polyurethane elastomers (TPUs).

The thermoplastic elastomers based on dynamically vulcanized elastomer-thermoplastic blends of the present invention are generally made through the relatively new processing technology referred to as "dynamic vulcanization." This proprietary processing
10 technology has provided several novel thermoplastic elastomer materials (referred to herein as "thermoplastic vulcanizates") that have many properties as good or even, in some aspects, better than those of more traditional styrenic tri-block copolymers. Exemplary in this regard are the proprietary products prepared by the dynamic vulcanization of blends of olefin rubber with polyolefin resin such as those sold by Shell and Advanced Elastomer
15 Systems (Shell Chemical Company, United States; Advanced Elastomer Systems, L.P., United States) under the tradename SANTOPRENE. Other thermoplastic vulcanizates, now generally referred to as TPVs, include various blends of ethylene-propylene-diene terpolymer (EPDM) elastomer with polypropylene and/or polyethylene, as well as blends of polyolefin with diene rubbers such as butyl rubber, natural rubber, acrylonitrile-
20 butadiene copolymer (NBR), and styrene-butadiene copolymer (SBR).

The thermoplastic polyether ester elastomers of the present invention are generally multiblock copolyether esters with alternating, random-length sequences of either long-chain or short-chain oxyalkylene glycols connected by ester linkages. These materials are related structurally to the polyurethane and the polyamide thermoplastic elastomers in
25 that they also contain repeating high-melting blocks that are capable of crystallization (hard segments) and amorphous blocks having a relatively low glass transition temperature (soft segments). Typically, the hard segments are composed of short-chain cyclic ester units such as teramethylene terephthalate, whereas the soft segments are generally derived from aliphatic polyether glycols. Exemplary of the thermoplastic polyether ester elastomers are

the polyether-ester block copolymers sold by DuPont (DuPont Engineering Polymers) under the tradename HYTREL.

The thermoplastic elastomers based on polyamides of the present invention are generally characterized as having a polyamide hard segment and an aliphatic polyester, 5 aliphatic polyether, and/or aliphatic polycarbonate soft segment. The polyamide-based thermoplastic elastomers, like the TPVs, are relative newcomers to the family of thermoplastic elastomers.

The styrenic thermoplastic elastomers of the present invention are generally characterized as polystyrene-polydiene block copolymers, where both ends of each 10 polydiene chain are terminated by polystyrene segments. With this type of thermoplastic elastomer, the rigid polystyrene domains act as multifunctional junction points to give a crosslinked elastomer network similar in some aspects to that of conventional vulcanized rubber. The polystyrene segments may include substituted polystyrene such as, for example, poly(α -methylstyrene), copolymers of α -methylstyrene, and poly(*p*-*ter*i-butyl- 15 styrene), although these types of polystyrene segments are generally less preferred. In addition, the polydiene segments may include, for example, polyisoprene, polybutadiene, ethylene-propylene copolymers, and ethylene-butylene copolymers. Exemplary of the styrenic thermoplastic elastomers are those sold by Shell (Shell Chemical Company, United States) under the tradename KRATON, and those sold by GLS (GLS Corporation, 20 Thermoplastic Elastomers Division, United States). In this regard, the thermoplastic elastomer material of the present invention may comprise one or more styrenic block copolymers. Preferably, such styrenic block copolymers include one or more of a styrene-ethylene/butylene-styrene block copolymer (SEBS), a styrene-ethylene/propylene-styrene block copolymer (SEPS), a styrene-butadiene-styrene block copolymer (SBS), and a 25 styrene-isoprene-styrene block copolymer (SIS) (*e.g.*, KRATON thermoplastic elastomer compounds. Shell Chemical Company, United States). In one embodiment, the thermoplastic elastomer of the present invention comprises a styrene-ethylene/butylene-styrene block copolymer (*e.g.*, Tuftec, Asahi Chemicals, Japan). As is appreciated by those skilled in the art, SBS and SIS are A-B-A type block copolymers having unsaturated

elastomeric central segments, whereas SEBS and SEPS are A-B-A type block copolymers having saturated elastomeric central segments. Accordingly, and because of their structure, SBS and SIS are more sensitive to oxidation than SEBS and SEPS and are therefore less preferred.

5 The ethylene- α -olefin copolymers of the present invention generally comprise metallocene catalyzed ethylene- α -olefin copolymers, and more preferably, metallocene catalyzed ethylene- α -olefin copolymers selected from one or more of an ethylene-butene copolymer, an ethylene-hexane copolymer, and an ethylene-octene copolymer (any one of which may also be classified as a thermoplastic elastomer). In
10 general, the α -olefin component of the ethylene- α -olefin copolymer ranges from 2% to 30% by weight of the copolymer. Moreover, the metallocene catalyzed ethylene- α -olefin copolymers have densities (gm/cc) generally ranging from 0.86 to 0.95, melt indexes (ASTM 1238) generally ranging from 0.2 to 30, and melting points ($^{\circ}$ C, by DSC) generally ranging from 50-120. In one embodiment, the metallocene catalyzed ethylene- α -olefin
15 copolymer comprises an ethylene-octene copolymer (*e.g.*, Engage, Dupont Dow Elastomers, United States). As is appreciated by those skilled in the art, polymers manufactured using metallocene based catalyst technology have only been commercial available since about the early 1990s. More importantly, however, is that metallocene polymerization technology now allows for the manufacturing of relatively high molecular
20 weight copolymers of very specific tacticities (*e.g.*, isotactic and syndiotactic polymers), as well as the polymerization of almost any monomer – beyond the traditional C₃ to C₈ olefins – in an exact manner. (Note that a metallocene, as is appreciated by those skilled in the art, is a positively charged metal ion sandwiched between two negatively charged cyclopentadienyl anions).

25 In addition, those skilled in the art also recognize that ethylene- α -olefin copolymers, derived from metallocene based catalyst technology, include polyolefin “plastomers” or POPs (the name given to Exxon’s EXACT product line, which is manufactured with proprietary EXXPOL catalyst technology, Exxon Chemical, United States) and polyolefin “elastomers” or POEs (the name given to Dupont Dow Elastomer’s

ENGAGE product line, which is manufactured with its proprietary INSITE catalyst technology, Dupon Dow Elastomers LLC, United States). These new polyolefin plastomers (POPs) and elastomers (POEs) are recognized as low molecular weight, linear low density ethylene- α -olefin copolymers made possible as a result of metallocene based catalyst technology. Moreover, any one of the above-identified ethylene- α -olefin copolymers, or combinations thereof, may be used in the various compositions of the present invention.

In addition to having one or more of the foregoing thermoplastic elastomers, some of the exemplary unitary golf balls of the present invention also include an ethylene-vinyl acetate copolymer component. As is appreciated by those skilled in the art, ethylene-vinyl acetate copolymers are long chains of ethylene hydrocarbons with acetate groups randomly distributed throughout the chains. Ethylene is generally copolymerized with vinyl acetate to yield ethylene vinyl acetate copolymer. Exemplary of the commercially available ethylene-vinyl acetate copolymers include those available from DuPont (I.E. Du Pont de Nemours and Company, United States) under the tradename ELVAX.

In order to optimize processability, many of the above-described thermoplastic elastomer materials and/or ethylene-vinyl acetate copolymers may be compounded (albeit optionally) to a large extent with other polymers (*e.g.*, polypropylene, polyethylene, etc.), and may also be compounded with various oils, plasticizers, fillers and extenders, as well as other specialty additives (collectively referred to as processing additives). Indeed, and as appreciated by those skilled in the polymer compounding art, any number of various processing additives may be added to enhance one or more physical characteristics and properties of the unitary golf balls disclosed herein. Exemplary of such processing additives are those identified in Gächter R., Müller H., *The Plastics Additives Handbook*, 4th ed., Hanser Publishers, Munich, Germany (1996) (incorporated herein by reference in its entirety). Thus, and in some embodiments, the thermoplastic elastomer materials and/or ethylene-vinyl acetate copolymers of the present invention may optionally be compounded with an “extending oil” and/or a “filler” such as, for example, calcium carbonate. Such processing additives may improve the base composition’s overall

processability, and enhance certain performance characteristics of the unitary golf balls made therefrom.

As is appreciated by those skilled in the art, selected amounts of one or more of the above-identified ingredients (which are all associated with certain
5 embodiments of the present invention) may be compounded together as in the following exemplary manner. First, desired weight percentages of a selected thermoplastic elastomer (*e.g.*, 10-25% of a SEBS block copolymer having a Shore Hardness ranging from about 45 to 75) and an ethylene-vinyl acetate copolymer (*e.g.*, 65-75% of an ethylene-vinyl acetate copolymer, wherein the vinyl acetate content is about 15-18%), as well as desired amounts
10 of processing additives and other specialty chemicals (*e.g.*, colorants and stabilizers) may be added together in an appropriately sized first mixer. This dry blend may then be mixed and allowed to reach a temperature of 80°F prior to feeding to an appropriately sized second continuous mixer. The blades of the second continuous mixer may then be rotated (*e.g.*, at 175 rpm) so as to cause the dry blend to flux into a homogeneous melt at an
15 elevated temperature (*e.g.*, 340°F). The molten composition may then be transferred (*e.g.*, via a transfer line jacketed with nitrogen) to a single screw palletizing extruder, extruded through the die of the extruder (*e.g.*, a multi-hole die), cooled in a water bath, and strand cut through a cutter. The resulting pellets are then ready for manufacturing exemplary unitary golf balls of the present invention.

20 As is appreciated by those skilled in the art, the compounded ingredients (*e.g.*, pellets) of the present invention may be formed into unitary golf balls by, for example, injection molding (*e.g.*, use of a gated production mold in conjunction with a hot-runner system). Because the processing parameters associated with injection molding tend to vary substantially from one molding machine to another (due to factors such as, for
25 example, the compression ratio of the injection barrel, clearances of screw flights, size, age, etc.), the preferred processing parameters (*e.g.*, injection speeds, pressures, temperatures of the composition mix both in the barrel and after injection into the mold, etc.) associated with any particular machine needs to be established and optimized as is appreciated by those skilled in the art. Thus, and in connection with an exemplary gated and hot-runner

injection molding process, the feedstock ingredients are combined with a suitable blowing agent (*e.g.*, using automatic metering and mixing devices mounted directly on the injection molding machine), heated to a suitable temperature, and injected into one or more molds.

For example, a standard size golf ball may be made by injecting
5 approximately 13.5 grams of a suitable polymeric composition as disclosed herein into a golf ball shaped mold. In this regard, it has been discovered that, in general, the faster the injection speed the better the finished product. More specifically, it has been found that injection speeds faster than 0.2 seconds tends to produce golf balls having the lowest reject rate; however, speeds as slow as 0.45 may also be acceptable. Moreover, it has also been
10 found that if the injection speed is too slow, undesirable pre-foaming may occur which tends to reduce the surface quality among the foamed golf balls, and also tends to increase the variability of the internal cell structure among the foamed golf balls.

In general, the chemical blowing or foaming agents are specialty additives that evolve gas, such as N₂ or CO₂, through chemical reactions, so as to produce a foamed
15 internal cell structure within a polymeric matrix. In some embodiments, the blowing agent is an azodicarbonamide (or modified azocarbonamide), sodium bicarbonate, or a mixture thereof (*e.g.*, Spectratech FM1150H, Quantum Chemical Corp., United States). The blowing agent is generally temperature sensitive and comprises greater than about 1% by weight of the total feedstock, and typically comprises from about 6% to about 8% by
20 weight of the total feedstock. In general, the feedstock ingredients and blowing agent are heated at the point of injection (preferably ranging from about 310 to about 410 °F, and more preferably from about 350 to about 365 °F, but generally below the “kickoff” temperature of the selected blowing agent), in large part, due to the shear friction of rapidly passing through the small opening of the gate (thereby initiating the foaming of the
25 blowing agent). After a time period sufficient for the overall composition to effectively harden within the mold (preferably aided with cooling of the mold to a temperature ranging from about 50 to about 60 °F), the mold is opened and the formed unitary golf balls are removed.

In order to ensure better uniformity, it is also generally desirable to cool the just removed golf balls by immersion into a cold water bath for about 5 to about 7 minutes. Importantly, it has been discovered that the cold water bath is preferably thoroughly agitated by rapidly mixing and swirling the water such that the golf balls immersed therein rotate about, thereby ensuring that they cool more uniformly than if the water bath was not agitated. Put simply, if the water bath is not sufficiently agitated then any golf balls placed therein will tend to float on one side (namely, with their lighter side facing upward) and as a result will not cool uniformly. Thus, a stagnant water bath promotes non-uniform cooling and thus tends to form golf balls with one side being slightly more dense than the other.

For purposes of illustration and not limitation, the following examples more specifically disclose various aspects of the present invention.

EXAMPLES

In order to demonstrate some of the physical characteristics of the unitary golf balls of the present invention, several golf balls were made (having a weight distribution of about 11 grams to about 14 grams) and tested for average COR values as follows:

TABLE 1: Unitary Golf Ball Compositions and Average COR values

BALL	BASE	TPE	FOAM	COLOR	Avg. COR
1	82% Elvax 560	9% Santoprene 8211	8%	1% color	0.3774
2	82% Elvax 560	9% Santoprene 8211	8%	1%	0.3427
3	82% Elvax 560	9% Santoprene 8211	8%	1%	0.3893
4	72% Elvax 560	18% Dynaflex G 7736	8%	2%	0.3717
5	72% Elvax 560	18% Dynaflex G 7736	8%	2%	0.3889
6	72% Elvax 560	18% Dynaflex G 7736	8%	2%	0.3683
7	72% Elvax 560	18% Dynaflex G 7736	8%	2%Purple	0.3636
8	72% Elvax 560	18% Dynaflex G 7736	8%	2%	0.3565
9	72% Elvax 560	18% Dynaflex G 7736	8%	2%	0.383
10	72% Elvax 560	18% Dynaflex G 7736	8%	2%	0.36
11	72% Elvax 560	18% Dynaflex G 7736	8%	2%	0.3482
12	72% Elvax 560	18% Dynaflex G 7736	8%	2%Blue	0.3777
13	72% Elvax 560	18% Kraton 2104	8%	2%Pink	0.3664
14	72% Elvax 560	18% Kraton RP6653	8%	2%	0.3766

15	%100 Elvax 560	None	8%	2%Green	0.39595
16	72% Elvax 560	18% Dynaflex 2711	8%	2%	0.3781
17	82% Elvax 560	9% Dupont Engage	8%	2%	0.38905
18	69% EVA (59% 460, 41% 260)	17% Kraton 2104	9%	5%	0.36995
19	72% Elvax 560	18% Santoprene	8%	2%Blue	N/A
20	73% Elvax 460	18% Kraton 2701	7%	2%	0.33265
21	100% GLS 70Sur	None	8%	2%	0.3604

where Santoprene 8211 has Shore Hardness of about 35; Dynaflex G 7736 has a Shore Hardness of about 36; Dynaflex 2771 has Shore Hardness of about 45; Kraton 2104 has Shore Hardness of about 39; Kraton RP6653 has Shore Hardness of about 32; Kraton 2701 has Shore Hardness of about 70; and Dupont Engage has Shore Hardness of about 60.

- 5 In other Example, several other golf balls were made (having a weight distribution of about 11 grams to about 14 grams) from a polymeric mixture comprising about 25 relative weight percent EVA and about 75 relative weight percent TPE (excludes blowing agent and colorant weight percentages) and tested for average COR values as follows:

10

CHART 1: C.O.R. TEST FOR BALL (YELLOW#2-25%EVA/75%TPE) TEST SAMPLES FROM ALMOST GOLF

<u>BALL 2A</u>				<u>BALL 2B</u>			
	Vin	Vout	COR		Vin	Vout	COR
	142.82	55.54	0.3889		136.80	52.91	0.3868
	146.18	54.17	0.3706		146.01	51.75	0.3544
	143.2	50.27	0.3510		140.04	51.73	0.3694
	143.97	52.54	0.3649		142.92	53.18	0.3721
	135.54	48.80	0.3600		139.57	54.12	0.3878
	137.04	51.39	0.3750		147.99	53.50	0.3615
	147.19	55.03	0.3739		142.98	52.38	0.3663
	145.99	55.30	0.3788		143.68	52.71	0.3669
AVG=	142.74	52.88	0.3704	AVG=	142.50	52.79	0.3706
SD=	4.28	2.54	0.0117	SD=	3.61	0.83	0.0116
RUNOUT=	.020(BEFORE)/.050(AFTER)			RUNOUT=	.015(BEFORE)/.040(AFTER)		
<u>BALL 2C</u>				<u>BALL 2D</u>			
	Vin	Vout	COR		Vin	Vout	COR
	138.52	53.67	0.3875		132.70	51.59	0.3888
	134.61	55.21	0.4101		142.59	51.28	0.3596

148.17	51.37	0.3467
139.00	52.55	0.3781
145.03	51.98	0.3584
149.70	52.13	0.3482
138.81	50.86	0.3664
140.39	51.94	0.3700

142.73	52.83	0.3701
147.25	54.04	0.3670
136.18	50.81	0.3731
144.53	52.41	0.3626
154.46	52.22	0.3381
144.36	50.06	0.3468

AVG= 141.78 52.46 0.3707
SD= 5.27 1.38 0.0212
RUNOUT= .010(BEFORE)/.040(AFTER)

AVG= 143.10 51.91 0.3633
SD= 6.62 1.25 0.0157
RUNOUT= .030(BEFORE)/.075(AFTER)

BALL 2E

BALL 2F

Vin	Vout	COR
136.71	51.74	0.3785
139.57	52.05	0.3729
132.82	52.64	0.3963
146.11	54.22	0.3711
136.28	54.66	0.4011
149.95	57.66	0.3845
149.63	53.83	0.3598
152.09	53.79	0.3537

Vin	Vout	COR
142.03	52.63	0.3706
137.91	52.58	0.3813
141.58	53.99	0.3813
141.26	50.70	0.3589
147.82	52.56	0.3556
142.47	51.57	0.3620
147.93	52.97	0.3581
142.67	51.88	0.3636

AVG= 142.90 53.82 0.3772
SD= 7.41 1.87 0.0165
RUNOUT= .025(BEFORE)/.070(AFTER)

AVG= 142.96 52.36 0.3664
SD= 3.38 0.99 0.0102
RUNOUT= .010(BEFORE)/.040(AFTER)

BALL 2G

BALL 2H

Vin	Vout	COR
147.78	56.42	0.3818
145.03	51.61	0.3559
147.45	51.57	0.3497
154.77	55.65	0.3596
145.33	51.41	0.3537
151.72	54.81	0.3613
147.60	53.41	0.3619
148.17	54.03	0.3646

Vin	Vout	COR
131.54	53.33	0.4054
136.50	51.74	0.3790
142.39	53.47	0.3755
146.11	54.88	0.3756
145.99	55.60	0.3808
136.59	53.63	0.3926
149.88	55.97	0.3734
139.57	54.61	0.3913

AVG= 148.48 53.61 0.3611
SD= 3.26 1.95 0.0097
RUNOUT= .020(BEFORE)/.035(AFTER)

AVG= 141.07 54.15 0.3842
SD= 6.13 1.38 0.0112
RUNOUT= .030(BEFORE)/.085(AFTER)

BALL 2I

BALL 2J

	Vin	Vout	COR		Vin	Vout	COR
	152.77	56.43	0.3694		148.85	54.36	0.3652
	153.19	54.98	0.3589		149.48	53.46	0.3576
	153.09	52.68	0.3441		143.58	50.39	0.3510
	153.00	54.10	0.3536		148.21	51.13	0.3450
	156.86	54.18	0.3454		140.10	49.43	0.3528
	155.45	56.34	0.3624		151.26	52.64	0.3480
	148.94	52.98	0.3557		143.41	51.05	0.3560
	153.09	53.10	0.3469		148.52	51.35	0.3457
AVG=	153.30	54.35	0.3545	AVG=	146.68	51.73	0.3527
SD=	2.29	1.46	0.0089	SD=	3.83	1.64	0.0068
RUNOUT=	.020(BEFORE)/.050(AFTER)			RUNOUT=	.015(BEFORE)/.050(AFTER)		

In yet another Example, several other golf balls were made (having a weight distribution of about 11 grams to about 14 grams) from a polymeric mixture comprising about 50 relative weight percent EVA and about 50 relative weight percent TPE (excludes blowing agent and colorant weight percentages) and tested for average COR values as follows:

CHART 2: C.O.R. TEST FOR BALL (YELLOW#1-50%EVA/50%TPE) TEST SAMPLES FROM ALMOST GOLF

<u>BALL 1A</u>				<u>BALL 1B</u>			
	Vin	Vout	COR		Vin	Vout	COR
	143.8	52.27	0.3635		138.72	53.09	0.3827
	136.71	51.34	0.3755		133.10	53.30	0.4005
	144.26	53.98	0.3742		133.80	52.64	0.3934
	146.07	54.26	0.3715		154.20	56.13	0.3640
	144.97	53.40	0.3684		129.27	51.86	0.4012
	141.74	53.86	0.3800		154.85	56.48	0.3647
	134.34	52.02	0.3872		129.13	51.73	0.4006
	136.02	52.12	0.3832		148.74	55.26	0.3715
AVG=	140.99	52.91	0.3754	AVG=	140.23	53.81	0.3848
SD=	4.60	1.10	0.0078	SD=	10.82	1.89	0.0163
RUNOUT=	0.015(BEFORE)/.035(AFTER)			RUNOUT=	0.035(BEFORE)/.080(AFTER)		
<u>BALL 1C</u>				<u>BALL 1D</u>			

Vin	Vout	COR
152.65	54.39	0.3563
150.97	54.83	0.3632
134.16	51.18	0.3815
148.70	53.13	0.3573
146.91	53.61	0.3649
143.29	46.99	0.3279
136.11	48.24	0.3544
140.49	48.22	0.3432

AVG= 144.16 51.32 0.3561
SD= 6.82 3.12 0.0157
RUNOUT= 0.030(BEFORE)/.085(AFTER)

BALL 1E

Vin	Vout	COR
123.50	50.19	0.4064
133.46	53.63	0.4018
128.68	53.01	0.4120
136.48	54.20	0.3971
150.31	56.06	0.3730
120.90	49.83	0.4122
150.04	56.86	0.3790
126.36	51.85	0.4103

AVG= 133.72 53.20 0.3990
SD= 11.32 2.54 0.0152
RUNOUT= 0.055(BEFORE)/.120(AFTER)

BALL 1G

Vin	Vout	COR
151.70	55.05	0.3629
155.47	56.55	0.3637
153.02	56.29	0.3679
162.26	59.03	0.3638
148.41	54.94	0.3702
140.15	55.11	0.3932
144.03	51.96	0.3608
143.18	55.36	0.3866

AVG= 149.78 55.54 0.3711
SD= 7.31 1.98 0.0121
RUNOUT= 0.010(BEFORE)/.065(AFTER)

Vin	Vout	COR
160.46	47.64	0.2969
137.38	54.41	0.3961
140.06	53.86	0.3845
147.17	55.90	0.3798
148.15	54.82	0.3700
139.00	53.21	0.3828
143.97	54.86	0.3811
141.82	53.67	0.3784

AVG= 144.75 53.55 0.3712
SD= 7.39 2.53 0.0309
RUNOUT= 0.040(BEFORE)/.105(AFTER)

BALL 1F

Vin	Vout	COR
145.79	56.75	0.3893
147.49	57.09	0.3871
139.04	54.05	0.3887
156.27	57.36	0.3671
160.36	57.51	0.3586
140.27	55.08	0.3927
155.88	57.33	0.3678
153.70	57.10	0.3715

AVG= 149.85 56.53 0.3778
SD= 7.87 1.27 0.0130
RUNOUT= 0.045(BEFORE)/.100(AFTER)

BALL 1H

Vin	Vout	COR
138.60	54.68	0.3945
144.38	54.76	0.3793
147.04	54.93	0.3736
149.32	53.09	0.3555
156.84	55.66	0.3549
159.08	55.63	0.3497
140.86	53.06	0.3767
159.54	55.81	0.3498

AVG= 149.46 54.70 0.3667
SD= 8.21 1.09 0.0165
RUNOUT= 0.050(BEFORE)/.080(AFTER)

<u>BALL 1I</u>				<u>BALL 1J</u>			
	Vin	Vout	COR		Vin	Vout	COR
	157.83	55.54	0.3519		149.70	53.73	0.3589
	146.03	54.39	0.3725		132.89	51.86	0.3902
	154.58	54.44	0.3522		137.59	52.30	0.3801
	158.25	54.48	0.3443		147.12	53.26	0.3620
	154.32	54.09	0.3505		142.29	53.35	0.3749
	163.91	57.46	0.3506		134.50	52.47	0.3901
	157.68	53.14	0.3370		141.96	53.84	0.3793
	144.28	52.91	0.3667		141.68	52.71	0.3720
AVG=	154.61	54.56	0.3532	AVG=	140.97	52.94	0.3760
SD=	6.55	1.43	0.0114	SD=	5.80	0.71	0.0116
RUNOUT=	0.020(BEFORE)/.065(AFTER)			RUNOUT=	0.010(BEFORE)/.065(AFTER)		

<u>BALL 1K</u>				<u>BALL 1L</u>			
	Vin	Vout	COR		Vin	Vout	COR
	149.61	55.13	0.3685		138.72	52.63	0.3794
	145.48	53.67	0.3689		142.78	53.20	0.3726
	150.06	53.68	0.3577		134.44	53.31	0.3965
	145.94	54.20	0.3714		148.68	55.21	0.3713
	149.97	55.07	0.3672		149.10	55.07	0.3693
	145.37	52.65	0.3622		136.91	53.51	0.3908
	143.10	54.26	0.3792		149.34	53.61	0.3590
	153.63	53.75	0.3499		138.26	54.65	0.3953
AVG=	147.90	54.05	0.3656	AVG=	142.28	53.90	0.3793
SD=	3.46	0.81	0.0090	SD=	6.06	0.95	0.0137
RUNOUT=	0.015(BEFORE)/.065(AFTER)			RUNOUT=	0.010(BEFORE)/.045(AFTER)		

In still yet another Example, several other golf balls were made (having a weight distribution of about 11 grams to about 14 grams) from a polymeric mixture comprising about 68 weight percent EVA, about 16.5 weight percent polypropylene, about 5.7 weight percent TPE, about 8 weight percent blowing agent, and about 1.8 weight percent yellow colorant, and tested for average COR values as follows:

CHART 3: C.O.R. TEST FOR BALL (YELLOW 68%EVA/16.5%PP/5.7%TPE)
TEST SAMPLES FROM ALMOST GOLF

<u>BALL 1</u>				<u>BALL 2</u>			
	Vin	Vout	COR		Vin	Vout	COR
	140.61	51.96	0.3695		143.55	50.97	0.3551
	144.36	54.82	0.3797		147.78	52.01	0.3519
	140.08	52.13	0.3721		144.59	51.45	0.3558
	146.43	53.12	0.3628		140.19	51.51	0.3674
	138.89	51.91	0.3737		136.39	50.89	0.3731
	135.87	52.04	0.3830		146.41	53.89	0.3681
	134.66	52.38	0.3890		141.20	50.82	0.3599
	153.78	56.53	0.3676		144.74	51.78	0.3577
AVG=	141.84	53.11	0.3747	AVG=	143.11	51.67	0.3611
SD=	6.22	1.69	0.0087	SD=	3.69	1.00	0.0075
RUNOUTi=	0.01			RUNOUTi=	0.010		
RUNOUTf=	0.065			RUNOUTf=	0.04		
<u>BALL 3</u>				<u>BALL 4</u>			
	Vin	Vout	COR		Vin	Vout	COR
	148.39	55.46	0.3737		149.39	54.04	0.3617
	144.91	53.95	0.3723		143.23	54.74	0.3822
	143.84	54.56	0.3793		148.92	53.58	0.3598
	141.28	52.65	0.3727		142.19	54.56	0.3837
	141.74	52.94	0.3735		149.23	52.54	0.3521
	139.55	53.06	0.3802		146.76	54.85	0.3737
	144.63	55.01	0.3803		146.20	53.71	0.3674
	149.84	54.02	0.3605		140.15	54.32	0.3876
	144.27	53.96	0.3741	AVG=	145.76	54.04	0.3710
SD=	3.51	1.02	0.0065	SD=	3.53	0.76	0.0128
RUNOUTi=	0.010			RUNOUTi=	0.005		
RUNOUTf=	0.06			RUNOUTf=	0.07		
<u>BALL 5</u>				<u>BALL 6</u>			
	Vin	Vout	COR		Vin	Vout	COR
	138.79	50.94	0.3670		147.60	54.50	0.3692
	138.10	50.96	0.3690		143.00	52.59	0.3678
	143.88	54.94	0.3818		150.58	55.84	0.3708
	147.08	53.92	0.3666		143.74	53.84	0.3746
	140.73	51.96	0.3692		149.23	53.62	0.3593
	141.70	52.06	0.3674		144.24	53.55	0.3713
	145.31	54.52	0.3752		144.01	54.75	0.3802
	146.76	53.61	0.3653		139.24	52.61	0.3778

AVG= 142.79 52.86 0.3702
 SD= 3.49 1.58 0.0056
 RUNOUTi= 0.015
 RUNOUTf= 0.08

BALL 7

Vin	Vout	COR
142.53	52.57	0.3688
145.45	55.14	0.3791
145.24	54.74	0.3769
143.82	53.30	0.3706
146.82	54.89	0.3739
143.49	53.61	0.3736
142.82	54.84	0.3840
140.27	53.20	0.3793

AVG= 143.81 54.04 0.3758
 SD= 2.04 0.98 0.0050
 RUNOUTi= 0.010
 RUNOUTf= 0.065

BALL 9

Vin	Vout	COR
139.65	52.19	0.3737
143.00	54.93	0.3841
149.01	55.19	0.3704
139.70	54.11	0.3873
148.26	54.35	0.3666
145.79	56.39	0.3868
145.82	53.17	0.3646
140.90	52.56	0.3730

AVG= 144.02 54.11 0.3758
 SD= 3.74 1.42 0.0091
 RUNOUTi= 0.015
 RUNOUTf= 0.06

BALL 11

Vin	Vout	COR
143.23	53.24	0.3717
143.76	53.46	0.3719
139.39	53.90	0.3867
143.14	55.32	0.3865
144.22	53.32	0.3697
144.61	53.04	0.3668

AVG= 145.21 53.91 0.3714
 SD= 3.70 1.10 0.0065
 RUNOUTi= 0.010
 RUNOUTf= 0.05

BALL 8

Vin	Vout	COR
144.97	52.58	0.3627
142.09	52.87	0.3721
147.36	54.35	0.3688
145.05	52.92	0.3648
140.98	53.04	0.3762
140.47	52.31	0.3724
141.56	52.61	0.3716
148.13	53.57	0.3616

AVG= 143.83 53.03 0.3688
 SD= 2.96 0.65 0.0052
 RUNOUTi= 0.005
 RUNOUTf= 0.03

BALL 10

Vin	Vout	COR
146.54	52.97	0.3615
143.95	54.73	0.3802
146.41	53.26	0.3638
145.84	54.08	0.3708
142.61	53.35	0.3741
149.77	55.12	0.3680
149.10	55.47	0.3720
142.80	52.86	0.3702

AVG= 145.88 53.98 0.3701
 SD= 2.68 1.02 0.0059
 RUNOUTi= 0.005
 RUNOUTf= 0.07

BALL 12

Vin	Vout	COR
148.37	54.04	0.3642
141.92	52.09	0.3670
144.13	51.82	0.3595
146.95	53.17	0.3618
146.69	53.40	0.3640
141.76	54.25	0.3827

	139.88	53.21	0.3804		147.32	54.59	0.3706
	139.30	52.52	0.3770		142.88	54.90	0.3842
AVG=	142.19	53.50	0.3763	AVG=	145.00	53.53	0.3693
SD=	2.27	0.83	0.0076	SD=	2.64	1.13	0.0094
RUNOUTi=	0.010			RUNOUTi=	0.005		
RUNOUTf=	0.05			RUNOUTf=	0.05		

While the present invention has been described in the context of the embodiments illustrated and described herein, the invention may be embodied in other specific ways or in other specific forms without departing from its spirit or essential characteristics. Therefore, the described embodiments are to be considered in all respects as illustrative and not restrictive. The scope of the invention is, therefore, indicated by the appended claims rather than by the foregoing description, and all changes that come within the meaning and range of equivalency of the claims are to be embraced within their scope.